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(54) Apparatus for and method of production of a camshaft

(57) A composite camshaft is produced by slidably assembling a succession of individual cam elements 10 on a cylindrical common shaft 16. All of the cam elements are initially preassembled on a guide bar 14 and are then transferred successively on to the co-axially mounted shaft 16 which has adhesive applied thereto at a succession of predetermined axial positions. After each camshaft element has been located on the shaft 16, it is rotatably indexed to a predetermined angular orientation to receive the next camshaft element from the guide bar 14 at a next predetermined axial position at which adhesive has been applied.

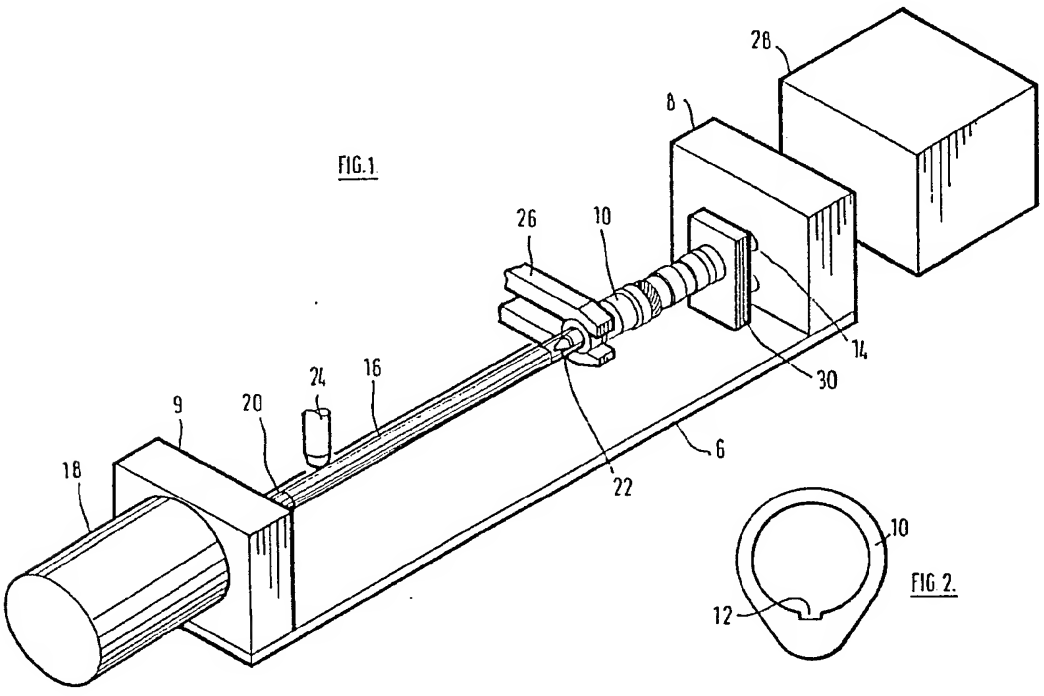

FIG.1.

FIG 2.

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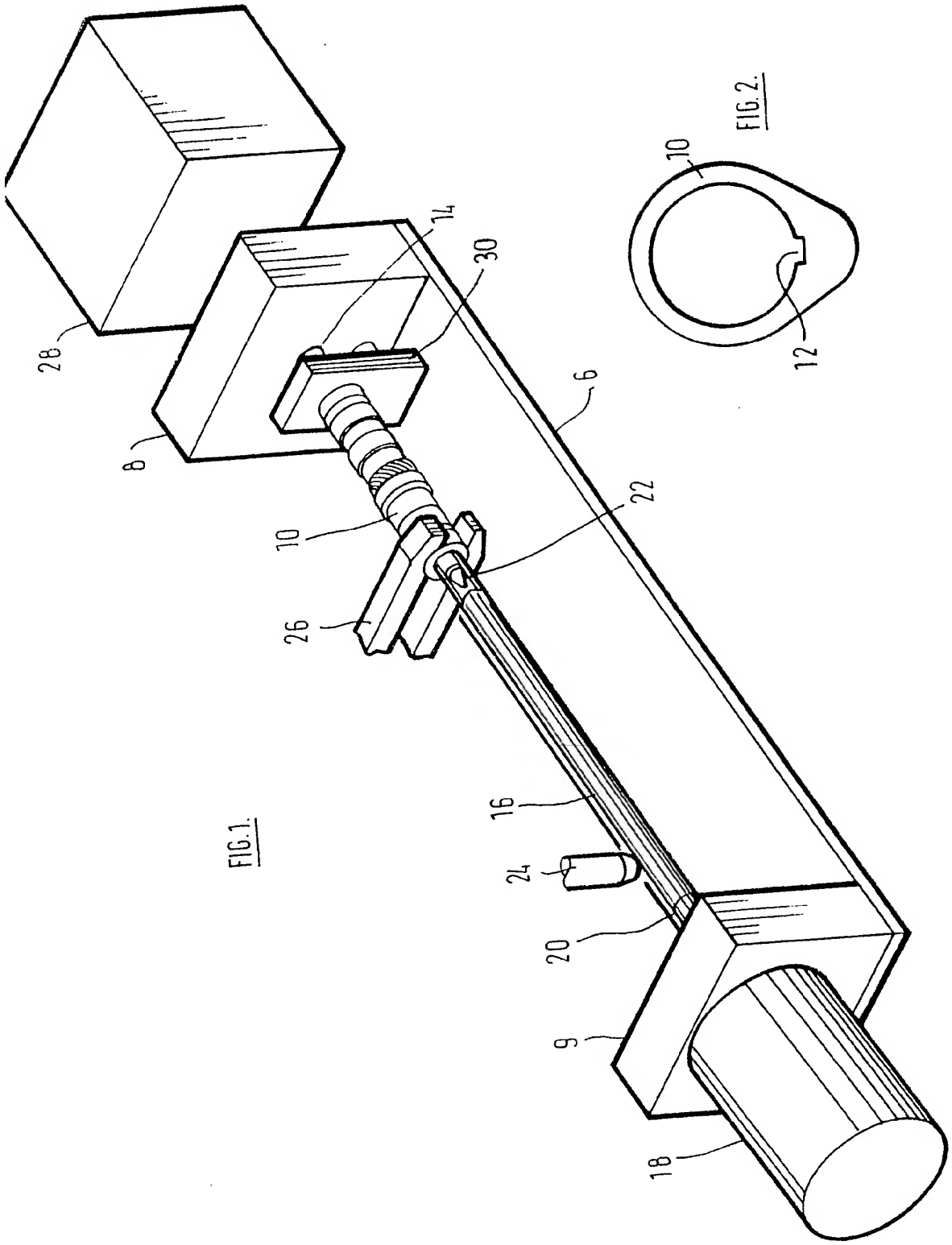

FIG.1.

FIG.2.

SPECIFICATION

Apparatus for and method of production of a camshaft

This invention relates to a camshaft and is particularly concerned with a composite camshaft, and method of and apparatus for its production, of the type comprising a plurality of separate cam elements assembled on a common shaft.

Composite camshafts have already been proposed as an alternative to the well known cast and forged forms of camshaft wherein the entire camshaft has been either formed as a steel casting in a mould or forged from bar. For example, a composite camshaft is disclosed in GN—A—2121908 which comprises a plurality of sintered metal cams assembled on a common shaft; the angular orientation of the individual cams relative to one another being determined by means of a plurality of longitudinal groove or splines on the shaft on which at least one cooperating respective projection or grove on each cam is located. In this construction the cams are metallurgically bonded to the shaft by a liquid phase sintering process after they have been located in their predetermined axial and angular positions on the shaft.

It is an object of the present invention to provide a composite camshaft and method of and apparatus for its production which will offer ease and economy of production in comparison with already known methods.

In accordance with the invention there is provided a method of producing a composite camshaft comprising

1. slidably assembling a plurality of individual cam elements on a guide bar by engaging a groove on each cam on a rib extending longitudinally of the guide bar

2. aligning the guide bar with a rotatably mounted cylindrical shaft upon which the cam elements are to be secured at predetermined axial positions therealong and at predetermined angular orientations with respect to one another

3. applying an adhesive at a first predetermined position on the shaft

4. sliding a first cam element off the guide bar on to the shaft to said first predetermined position whereby said first cam element is adhesively secured to said shaft and

5. rotatably indexing the shaft to a succession of predetermined angular orientations and applying adhesive thereto at a succession of predetermined axial positions whereby each of successive cam elements may be slid off the guide bar and located and adhesively secured to the shaft at a said predetermined axial position and at a said predetermined angular orientation.

Also in accordance with the invention there is provided apparatus for the production of a composite camshaft wherein a plurality of individual cam elements are slidably assembled on a cylindrical shaft comprising

1. a guide bar having a longitudinally extending rib on which the cam elements are mountable by means of a groove on each cam element engaged on said rib

2. means for rotatably mounting the shaft coaxial with the guide bar

3. indexing means for rotating the shaft successively to a plurality of predetermined angular orientations

4. Means for applying an adhesive to the shaft successively at a plurality of predetermined axial positions therealong and

5. means for transferring the cam elements successively from the guide bar to the shaft to a said predetermined axial position when the shaft is indexed to a said predetermined angular orientation.

Preferably each cam element is successively pulled from the guide bar and slid along the shaft to its said predetermined axial position at which it is to be adhesively secured by a releasable gripper means movable axially of the shaft.

The adhesive may be applied by an applicator in spray or droplet form and said applicator is conveniently traversable axially of the shaft for effecting application of the adhesive at each of the said predetermined axial positions.

Preferably each cam element on the guide bar is pushed successively to a position on the guide bar at which the cam element is engageable by the gripper means.

Control means may be provided to actuate the shaft indexing means, the adhesive applying means, the transfer means, the pusher means and the means for traversing the adhesive applying means in predetermined sequence.

The composite cam shaft produced by the method and apparatus described in the preceding paragraphs preferably comprises a plurality of individual sintered metal cam elements produced by a powder metallurgy process assembled on a hollow steel shaft.

Other features of the invention will become apparent from the following description given herein solely by way of example with reference to the accompanying drawings wherein.

Figure 1 is a diagrammatic isometric view of apparatus in accordance with the invention and

Figure 2 is a diagrammatic end elevation of an individual cam element.

In Figure 1 of the drawings, there is illustrated apparatus in accordance with the invention for the production of a composite camshaft for an internal combustion engine. The apparatus comprises a base 6 having two end supports 8 and 9 and, in this embodiment, the base 6 is disposed horizontally, A plurality of individual cam elements 10 each having a cylindrical bore with a groove 12 extending axially thereof are initially assembled upon a guide bar 14 mounted to project horizontally from the end support 8.

Although not visible from Figure 1, the guide bar 14 is provided with a longitudinally extending rib whereby all of the cam elements 10 may be slidably assembled on the guide bar by engaging the groove 12 of each cam element 10 on the rib. The guide bar and assembled cam elements are shown in Figure 1 together with other cam shaft elements between the

cam elements 10; such other elements comprising for example journals and a helical gear which may be utilised for driving the distributor of an internal combustion engine. The cam elements 10 and other camshaft elements may be formed of any suitable material but it is preferred that at least the cam elements 10 are formed of an iron based sintered metal.

All of the cam elements 10 are thus slidably preassembled on the guide bar 14 in their correct sequence and the same angular orientation with respect to one another. All of the camshaft elements, including the cam elements 10, are to be located in predetermined axial positions on a common shaft 16 which may be either hollow or solid and may conveniently comprise a steel tubular member. The shaft 16 is mounted co-axial with the guide bar 14 and is rotatably indexable about its longitudinal axis by means of a stepping motor 18 mounted on the other end support 9. The motor 18 drives a support spindle 20 upon which the shaft is mounted, the other end of the shaft 16 being freely mounted for rotation on the free end 22 of the guide bar 14. The apparatus further includes an adhesive applicator 24 for dropping or spraying adhesive at predetermined axial locations of the shaft 16. The applicator 24 is mounted on traversing means (not shown) whereby the applicator itself may be moved successively to each of a plurality of predetermined axial positions along the shaft 16.

There is also provided a gripper means 26 comprising a "pick and place" unit which is appropriately programmed and controlled to pull successive camshaft elements off the guide bar 14 and slide them along the shaft 16 to their correct predetermined axial position. Each camshaft element is moved to its position adjacent the free end 22 of the guide bar 14 at which it may be engaged by the gripper means 26 by means of a pusher mechanism comprising a motor 28 and pusher ram 30. The motor 28 may operate a worm and nut mechanism or a fluid pressure actuated mechanism to cause the pusher ram 30 to push each of successive camshaft elements to the position adjacent the gripper means 26.

In use of the apparatus, the cam elements 10 and other camshaft elements are initially slidably preassembled on the guide bar 14 as shown in Figure 1. Adhesive is applied to a first predetermined axial position on the shaft 16 by the applicator 24 and the gripper means 26 is actuated to engage the end element on the guide bar 14 and traversed to pull such element off the guide bar and slide it axially on to the shaft 16 to said first predetermined position at which the adhesive has been applied. The stepping motor 18 is then actuated to rotate the shaft 16 to a next predetermined angular orientation and the applicator 24 is moved to the next predetermined axial position and adhesive is applied to the shaft 16 at such position. The motor 28 is also actuated to cause the ram 30 to push the next camshaft element into the position at which it may be engaged by the gripper means 26 and the cycle may thus be repeated until all of the camshaft elements are positioned successively on the shaft 16 at their correct predetermined axial positions with the cam elements 10 in predetermined angular orientation relative to one another as determined by the angular movement imparted to the shaft by the stepping motor 18.

A control means (not shown) is provided to actuate the stepping motor 18, the adhesive applicator 24, the means for traversing the adhesive applicator, the gripper means 26, the means for traversing the gripper means, and the pusher motor 28 in a predetermined sequence.

After all of the camshaft elements have been assembled on and adhesively secured to the shaft 16, the composite camshaft is removed from the apparatus and subjected to a separate heat treatment to impart wear resistence to the cam elements 10 and to permanently fix the cam elements 10 and the other camshaft elements to the shaft 16 both mechanically and metallurgically.

CLAIMS

1. A method of producing a composite camshaft comprising

1) slidably assembling a plurality of individual cam elements on a guide bar by engaging a groove on each cam on a rib extending longitudinally of the guide bar

2) aligning the guide bar with a rotatably mounted cylindrical shaft upon which the cam elements are to be secured at predetermined axial positions therealong and at predetermined angular orientations with respect to one another

3) applying an adhesive at a first predetermined position on the shaft

4) sliding a first cam element off the guide bar on to the shaft to said first predetermined position whereby said first cam element is adhesively secured to said shaft and

5) rotatably indexing the shaft to a succession of predetermined angular orientations and applying adhesive thereto at a succession of predetermined axial positions whereby each of successive cam elements may be slid off the guide bar and located and adhesively secured to the shaft at a said predetermined axial position and at a said predetermined angular orientation.

2. A method according to Claim 1 wherein each cam element is successively pulled from said guide bar and slid along the shaft to its said predetermined axial position at which it is to be adhesively secured to the shaft.

3. A method according to either one of Claims 1 or 2 wherein each cam element is successively removed from the guide bar and slid on to the shaft by a releasable gripper means movable axially of the shaft.

4. A method according to Claim 3 wherein each cam element on the guide bar is pushed successively to a position on the guide bar at which the cam element is engageable by said gripper means.

5. A method according to any one of the preceding claims wherein the adhesive is applied by an applicator movable axially of the shaft.

6. A method of producing a composite camshaft substantially as hereinbefore described with reference to the accompanying drawings.

7. Apparatus for the production of a composite camshaft wherein a plurality of individual cam elements are slidably assembled on a cylindrical shaft comprising

1) a guide bar having a longitudinally extending rib on which the cam elements are mountable by means of a groove on each cam element engaged on said rib

2) means for rotatably mounting the shaft coaxial with the guide bar

3) indexing means for rotating the shaft successively to a plurality of predetermined angular orientations

4) means for applying an adhesive to the shaft successively at a plurality of predetermined axial positions therealong and

5) means for transferring the cam elements successively from the guide bar to the shaft to a said predetermined axial position when the shaft is indexed to a said predetermined angular orientation.

8. Apparatus as claimed in Claim 7 further including pusher means for successively pushing each cam element to a position at which it is engageable by said transfer means.

9. Apparatus as claimed in either one of Claims 7 or 8 further including means for traversing the adhesive applying means axially of the shaft to each of said predetermined axial positions.

10. Apparatus as claimed in Claim 9 wherein control means are provided to actuate the shaft indexing means, the adhesive supplying means, the transfer means, the pusher means and the traversing means in a predetermined sequence.

11. Apparatus for the production of a composite camshaft substantially as hereinbefore described with reference to the accompanying drawings.

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